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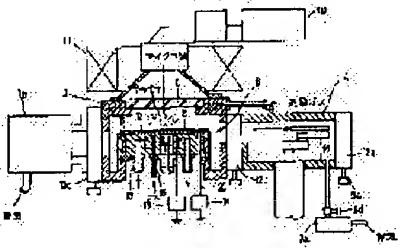
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## **(54) PLASMA TREATING DEVICE**

### **(57)Abstract:**

PURPOSE: To regulate the temp. of a protective plate to a necessary specified temp. by providing a plasma treating device with a protective plate temp. regulating means for regulating the temp. of the protective plate arranged around a sample to be subjected to a plasma treatment.

CONSTITUTION: The protective plate temp. regulating means conducts the heat of the protective plate 6 to a stage 8 by fixing the protective plate 6 to this stage 8 and maintains the specified temp. of the protective plate 6 by regulating the conduction state. Then, the influence of the temp. rise and temp. fluctuation of the protective plate 6 on the plasma treatment is eliminated and the precise control and reproduction characteristics of the plasma treatment are improved. Since the reaction state of the plasma and the sample 2 is changed by controlling the temp. of the protective plate 6 and is, therefore, usable as a parameter for controlling the plasma treatment, the control width of the plasma treatment is widened.



## **LEGAL STATUS**

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CLAIMS

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[Claim(s)]

[Claim 1] The plasma-treatment equipment characterized by to establish a protection plate temperature-control means adjust the temperature of the protection plate arranged around the above-mentioned sample installation position on the above-mentioned installation base in the plasma-treatment equipment which carries out plasma treatment of the sample laid on the installation base which plasma-ized the raw gas introduced in the vacuum housing, and has been arranged by this plasma in the above-mentioned vacuum housing.

[Claim 2] Plasma treatment equipment according to claim 1 with which the above-mentioned protection plate temperature-control means adjusted the pressure of the gas with which it fills up between a protection plate and an installation base.

[Claim 3] Plasma treatment equipment according to claim 1 which forms a conductor film in the above-mentioned protection plate, and fixed the above-mentioned protection plate to the predetermined position on an installation base by the electrostatic chuck while preparing the electrostatic chuck in the above-mentioned installation base.

[Claim 4] Plasma treatment equipment according to claim 1 with which the above-mentioned protection plate temperature-control means prepares a heater and a temperature sensor in a protection plate, and was made to perform the temperature control of a protection plate based on detection temperature.

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**DETAILED DESCRIPTION**

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[Detailed Description of the Invention]

[0001]

[Industrial Application] this invention relates to the plasma treatment equipment used for manufacture processes, such as a semiconductor integrated circuit, and relates to the plasma treatment equipment which can keep constant the temperature of the protection plate arranged by the circumference of a sample so that plasma treatment, such as CVD and etching, may be stabilized and it can carry out.

[0002]

[Description of the Prior Art] Drawing 6 is the \*\* type view showing the outline of plasma treatment equipment. It can plasma-ize using an appropriate plasma generating means by which the raw gas introduced in the vacuum housing 30 is not illustrated, and necessary plasma treatment can be performed by irradiating the ion and radical which were generated by plasma to the sample 31 arranged in the above-mentioned vacuum housing 30. Although the above-mentioned sample 31 is laid on the installation base 32 arranged in the vacuum housing 30, the path of the installation base 32 is usually made larger than the path of a sample 31, and a sample 31 is laid near [ the ] a center so that the plasma treatment to a sample 31 may be made uniformly. Therefore, the front face of the installation base 32 will be exposed to the circumference of a sample 31. Since the above-mentioned installation base 32 is formed of metal materials, such as aluminum and stainless steel, in order to protect the exposure front face of the installation base 32 \*\*(ed) by plasma irradiation, the protection plate 33 formed in this position with a ceramic, a quartz, etc. is laid.

[0003]

[Problem(s) to be Solved by the Invention] However, in order that the above-mentioned protection plate may receive an ion bombardment during plasma treatment, it is heated and carries out a temperature rise sharply. When carrying out plasma treatment of two or more samples continuously, after temperature begins to rise at the time of the plasma treatment to the first sample and the temperature rise of this protection plate passes through a certain processing number of sheets, it will be in the steady state which settles down near constant temperature with a temperature rise. In order that temperature rise change of this protection plate might give change to the situation that the ion and radical in plasma react or adhere with a protection plate, it will affect the reaction of plasma and a sample and the problem from which the state of plasma treatment changes with the temperature of a protection plate had it. There was a trouble that the number of the samples which need to begin plasma treatment after it will process the sample of a dummy and a temperature rise will be in a steady state before starting plasma treatment in order to avoid this, therefore can be processed to per unit time decreased. Moreover, when changing the state of plasma in order that the temperature of the above-mentioned protection plate may control a processing reaction in order to change also with the density of plasma, or the pressures of a raw gas, it was influenced of the reaction of a protection plate and plasma, and had the trouble that control of a processing reaction became difficult. Furthermore, after the above-mentioned temperature rise settles in a steady state, there is temperature change which carries out [ change ] a temperature rise by the start of plasma treatment to the sample of one sheet, and carries out a temperature reduction with an end. Therefore, change arose also in the plasma treatment within the processing time, and there was a trouble that the plasma treatment as which precision is required became difficult. Then, the target place has this invention in offering the plasma treatment equipment which can adjust the temperature of the above-mentioned protection plate compulsorily, and can be controlled to a necessary constant temperature.

[0004]

[Means for Solving the Problem] The means which this invention adopts in order to attain the above-mentioned purpose In the plasma treatment equipment which carries out plasma treatment of the sample laid on the installation base which plasma-ized the raw gas introduced in the vacuum housing, and has been arranged by this plasma in the above-mentioned vacuum housing It is constituted as plasma treatment equipment characterized by establishing a protection plate temperature-control means to adjust the temperature of the protection plate arranged around the above-mentioned sample installation position on the above-mentioned installation base. The above-mentioned protection plate temperature-control means can be constituted so that the pressure of the gas with which it filled up between the protection plate and the installation base may be adjusted. Moreover, while preparing an electrostatic chuck in the above-mentioned installation base, a conductor film can be formed in the above-mentioned protection plate, and it can constitute so that the above-mentioned protection plate may be fixed to the predetermined position on an installation base by the electrostatic chuck. Furthermore, the above-mentioned protection plate temperature-control means can prepare a heater and a temperature sensor in a protection plate, and it can constitute so that the temperature control of a protection plate may be performed based on detection temperature.

[0005]

[Function] Although the temperature rise of the protection plate was carried out by the shock of the ion generated by plasma, since the protection plate was only conventionally laid on the installation base, the state where there was a gap of the vacua in a vacuum housing and there was no refuge of heat was suited between installation bases. Then, the protection plate temperature-control means concerning this invention keeps the temperature of a protection plate constant by adjusting the conduction state while it fixes a protection plate on an installation base and makes an installation base conduct the heat of a protection plate. Therefore, the influence on the plasma treatment which the temperature rise of a protection plate and temperature change do is canceled, and precise control and precise repeatability of plasma treatment improve. Moreover, since the reaction state of plasma and a sample can be changed by controlling the temperature of a protection plate, it can use as a parameter which controls plasma treatment, and the control width of face of plasma treatment can be expanded. By adjusting in the direction of low temperature, the temperature of a protection plate can reduce the response probability of the ion and protection plate by the ion bombardment, and can suppress exhaustion of a protection plate. By adjusting the pressure of the gas with which it was filled up between the protection plate and the installation base, the temperature-control means of the above-mentioned protection plate can adjust the conductivity of heat, and can plan the temperature control of a protection plate. Moreover, fixation of a up to [ the installation base of a protection plate ] can also be carried out by the electrostatic chuck, and the adhesion of a protection plate required for heat conduction and an installation base improves. At this time, a conductor film is formed in the protection plate formed with a ceramic etc., and adsorption of the protection plate by the electrostatic chuck is enabled. Furthermore, when it seems that he wants to keep the temperature of a protection plate high and to carry out plasma treatment, the heater and temperature sensor for heating are prepared in a protection plate, it is made to correspond to the temperature of the protection plate which carries out a temperature rise by the ion bombardment, heating at a heater is adjusted, and the temperature control which keeps a protection plate constant at high temperature is made.

[0006]

[Example] With reference to an accompanying drawing, it explains hereafter per [ which materialized this invention ] example, and an understanding of this invention is presented. In addition, the following examples are examples which materialized this invention, and do not limit the technical range of this invention. The \*\* type view showing the composition of the plasma treatment equipment which drawing 1 requires for the 1st example of this invention in the state of a cross section here, the cross section showing the composition of the installation base which drawing 2 requires for an example, and drawing 3 between the protection plate concerning an example, and an electrode block The graph and drawing 5 which show the state of a temperature rise in case the graph and drawing 4 which show the relation of the gas pressure and the temperature fall with which it fills up do not carry out a protection plate temperature control are a graph which shows the state when carrying out a temperature control in the state which shows in drawing 4 . The plasma treatment equipment 1 concerning the example shown in drawing 1 is constituted as efficient consumer response plasma treatment equipment which used efficient consumer response (Electron Cyclotron Resonance) as a plasma generating means. efficient consumer response is a way stage of plasma generating where microwave, a magnetic field, and the electron in a raw gas produce a electron cyclotron resonance under efficient consumer response conditions, and a raw gas is plasma-ized as everyone knows. The plasma production for carrying out plasma treatment was not restricted to this means. while the 2.45GHz microwave which generated plasma treatment equipment 1 in the microwave oscillator 10 is introduced in a vacuum housing 3 from the microwave introduction aperture 5 in drawing 1 -- electromagnetism -- by generating the magnetic field which fulfills efficient consumer response conditions from a coil 11 in a vacuum housing 3, it is constituted so that the raw gas introduced in a vacuum housing 3 from the raw-gas introduction piping 9 may plasma-ize by efficient consumer response by microwave and the magnetic field Predetermined plasma treatment is made by irradiating the ion generated by this plasma and a radical at the sample 2 laid on the installation base 8 arranged in the vacuum housing 3.

[0007] The above-mentioned sample 2 is set on the arm 13 in a load lock chamber 4, is carried in by rotation of an arm 13 in a vacuum housing 3, and is laid in the predetermined position on the installation base 8. The sample 2 which plasma treatment ended is taken out by the arm 13 in a load lock chamber 4. In order to hold the vacua in a vacuum housing 3 and to perform this operation, each gates 12a, 12b, and 12c and vacuum pumps 7a and 7b are formed. The above-mentioned installation base 8 is constituted as shown in drawing 2 as an enlarged view. The electrostatic chuck 12 and the protection plate 6 are formed on the electrode block 14 supported by the vacuum housing 3 through the insulator 21, and a sample 2 is laid on the above-mentioned electrostatic chuck 12. From the refrigerant piping 15, a refrigerant is supplied and the above-mentioned electrode block 14 is cooled by the refrigerant path which was formed with aluminum and formed in the interior. The electrostatic chuck 12 can paste up on this electrode block 14, and electrostatic adsorption of the sample 2 laid with the voltage impressed from DC power supply 18 can be carried out. During processing, this electrostatic chuck 12 is for adjusting the temperature of the sample 2 under plasma treatment, and the gas supplied from the coolant-gas piping 16 between a sample 2 and the electrostatic chuck 12 is introduced, and heat conduction between a sample 2 and the electrostatic chuck 12 is promoted, and can maintain a sample 2 at fixed temperature to the temperature of the electrode block 14 cooled while the electrostatic chuck 12 is adsorbed. Moreover, RF bias voltage is impressed to the electrode block 14 from RF generator 17, and it is planned so that uniform plasma treatment may be made. The protection plate 6 is arranged around the above-mentioned sample 2, and the exposure front face of the electrode block 14 is protected. In this example, while the protection plate 6 is fixed to the electrode block 14 with a bolt 23, gaseous helium is supplied to the gap between O ring 22, and the protection plate 6 and the electrode block 14 which allotted 22 -- and was sealed from the protection plate coolant-gas piping 20 through a pressure regulator 19, and the protection plate temperature-control means of the protection plate 6 is constituted.

[0008] The ion with which plasma treatment is generated by plasma in a sample 2, and although it processes physically and

chemically radical therefore, ion and a radical arrive also at the part which touches the place where not only the sample 2 but plasma generates plasma, and it reacts or adheres. Therefore, the ion and radical which are consumed by parts other than sample 2 change the ion and the radical state in plasma. The situation that ion and a radical react or adhere changes with the temperature of the object part. Therefore, in order to maintain the reaction to a sample 2 at a fixed state, it becomes important to keep constant the temperature of the place which touches plasma. Especially the thing for which the temperature of the protection plate 6 in the contiguity position of a sample 2 is maintained at the fixed state is important, and, for the reason, the above-mentioned protection plate temperature-control means is constituted. Conventionally, with composition, since the protection plate 6 was only laid in the circumference of a sample 2, vacuum insulation of the heat which carried out the temperature rise by the ion bombardment is carried out, it does not have a refuge, and had had the bad influence on plasma treatment by the large temperature rise. Since heat conduction is controllable by this example composition by adjusting the pressure of the gas between which can make the electrode block 14 conduct the temperature of the protection plate 6, and it is moreover made to be placed between them as mentioned above, the temperature of the protection plate 6 can be kept constant. Although drawing 3 shows the relation between the temperature gradient between the protection plate 6 and the electrode block 14, and the pressure of the gaseous helium with which during this period is filled up and the rapid fall of a temperature gradient is seen by gas charging, even if it raises a pressure to 100 or more Torrs, it is hardly shortened by the temperature gradient. In addition, the protection plate 6 at this time and the surface roughness of the electrode block 14 are about 3 micrometers.

[0009] If gas charging is not performed at the plasma treatment start time but it is made the vacua in order to perform the temperature control of the protection plate 6 by using this gas as a heat-conduction medium, the temperature of the protection plate 6 will rise rapidly with a processing start. Although the situation of this temperature rise continues going up with time progress as shown in drawing 4, and it settles in a steady state after several minutes, the processing stabilized by the sample 2 which will be processed by the time it settles in this steady state is not made. And change of a temperature rise and a fall is repeated also for after a steady state for every processing start of a sample 2, and end. As for the plasma treatment with a high precision, in the state of the temperature change in composition, this is not conventionally made with this. Then, if gas charging of 100Torr(s) is performed after [ of a processing start ] about 15 seconds as shown in drawing 5, the temperature of the protection plate 6 will settle in fixed temperature. Since it is clear in the graph of drawing 3 which showed previously that, as for gas pressure, there was no great difference in the effect of a temperature control in at least 100 or more Torrs, gas pressure is good at 100 or less Torrs. A front face is in the vacua in a vacuum housing 3 by this, and the pressure differential by which gas pressure joins an opposite side is made small, and it becomes effective to form the protection plate 6 thinly according to the situation of plasma treatment. Concrete data show the result by the above-mentioned temperature control below. The electrode block 14 is cooled at 20 degrees C, and it is C4 F8 to a raw gas. It uses and is SiO<sub>2</sub> at microwave output 700W and RF bias 800V. It is data at the time of etching. It is SiO<sub>2</sub> when etched by controlling the protection plate 6 using the ceramic at 100 degrees C. The result of \*\*5% (6 inch wafer) in the homogeneity of the selection ratio 40 to 5000A a part for /and Si of etch rates, 89 etching configuration angles, and the etch rate within a sample side was obtained. Moreover, dispersion in processing from the 1st at the time of performing consecutive processing of 25 sheets to the 25th sheet was able to be suppressed within \*\*5%. Although this result is the example of etching processing, the same effect is demonstrated also in CVD and sputtering.

[0010] Although the above-mentioned example composition showed the example which used gaseous helium for the temperature control of the protection plate 6, as long as it is gas which is not corrosive, you may use the gas of other kinds. Moreover, it can also be filled up with the fluid which replaces gas, or grease between the protection plate 6 and the electrode block 14. Since the thermal conductivity in this case becomes very large as compared with gas, it is effective for bringing the temperature of the protection plate 6 close to the temperature of the electrode block 14. Furthermore, although the above-mentioned example composition showed the example using the bolt 23 as a means to fix the protection plate 6 on the electrode block 14, position fixation can also be carried out using an electrostatic chuck like a sample 2. Uniform fixing nature is obtained in the whole fixed side also in the state [ vacua ] where the vacuum housing 3 inside of the protection plate 6 is added, and, as for an opposite side, a gas-charging pressure is added and where there is a pressure differential. In using this electrostatic chuck, it forms the conductor film of a corrosion resistance in the field which touches the electrostatic chuck of the protection plate 6 by means, such as coating. Furthermore, when it seems that he wants to keep the temperature of the protection plate 6 high and to carry out plasma treatment and is made to correspond, while coating the protection plate 6 with a heating element (heater), a temperature sensor is attached, it can be made to be able to respond to the temperature rise by the ion bombardment of the protection plate 6, heating by the above-mentioned heating element can be adjusted, and the temperature-control method which maintains the protection plate 6 at necessary temperature can also be adopted.

[0011]

[Effect of the Invention] According to this invention, a temperature-control means is prepared in the protection plate arranged by the circumference of a sample as the above explanation. A temperature-control means keeps the temperature of a protection plate constant by adjusting the conduction state while it fixes a protection plate on an installation base and makes an installation base conduct the heat of a protection plate. Therefore, the influence on the plasma treatment which the temperature rise of a protection plate and temperature change do is canceled, and precise control and precise repeatability of plasma treatment improve. By adjusting the pressure of the gas with which it was filled up between the protection plate and the installation base, the temperature-control means of the above-mentioned protection plate can adjust the conductivity of heat, and can plan the temperature control of a protection plate. Since the reaction state of plasma and a sample can be changed by controlling the temperature of a protection plate, it can use as a parameter which controls plasma treatment, and the control width of face of plasma treatment can be expanded. Moreover, fixation of a up to [ the installation base of a protection plate ] can also be carried

out by the electrostatic chuck, and the adhesion of a protection plate required for heat conduction and an installation base improves. Furthermore, when it seems that he wants to keep the temperature of a protection plate high and to carry out plasma treatment, the heater and temperature sensor for heating are prepared in a protection plate, it is made to correspond to the temperature of the protection plate which carries out a temperature rise by the ion bombardment, heating at a heater is adjusted, and the temperature control which keeps a protection plate constant at high temperature is made.

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DESCRIPTION OF DRAWINGS

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[Brief Description of the Drawings]

[Drawing 1] The \*\* type view showing the composition of the plasma treatment equipment concerning one example of this invention.

[Drawing 2] The cross section showing the composition of the installation base concerning an example.

[Drawing 3] The graph which shows the relation of the gas pressure and the temperature gradient with which it fills up between the protection plates and electrode blocks concerning an example.

[Drawing 4] The graph which shows the state of the temperature rise of the protection plate when not performing the temperature control concerning an example.

[Drawing 5] The graph which shows the state at the time of carrying out the temperature control which starts an example from the state shown in drawing 4.

[Drawing 6] The \*\* type view showing the outline composition of the plasma treatment equipment concerning the conventional example.

[Description of Notations]

1 -- Plasma treatment equipment

2 -- Sample

3 -- Vacuum housing

6 -- Protection plate

8 -- Installation base

14 -- Electrode block

15 -- Refrigerant piping

19 -- Pressure regulator (protection plate temperature-control means)

20 -- Coolant-gas piping for protection plates (protection plate temperature-control means)

22 -- O ring (protection plate temperature-control means)

23 -- Bolt (protection plate temperature-control means)

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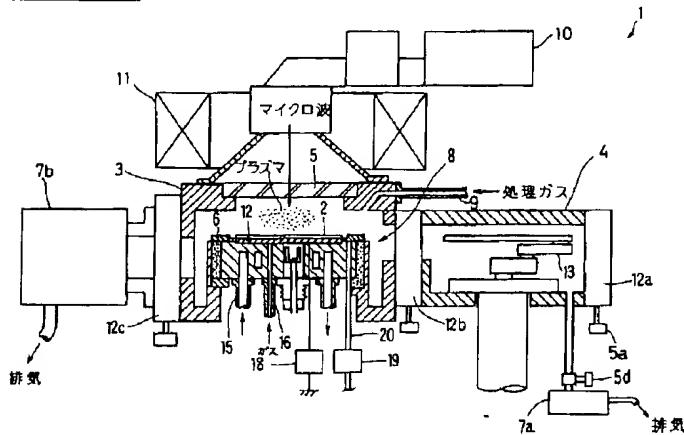
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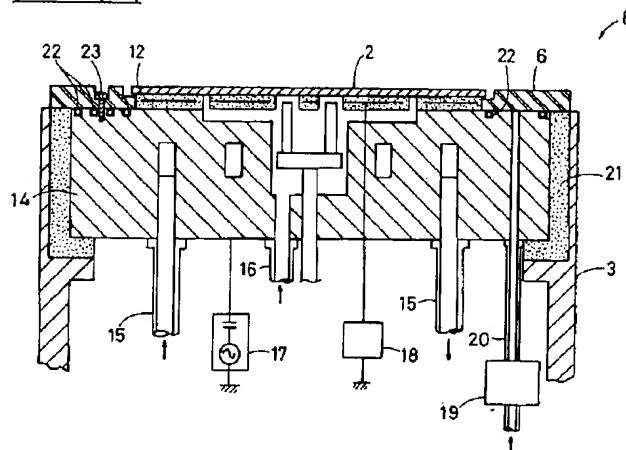
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DRAWINGS

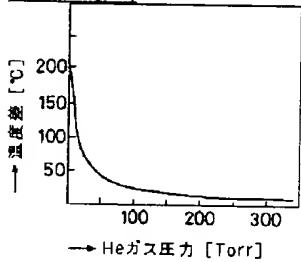
[Drawing 1]



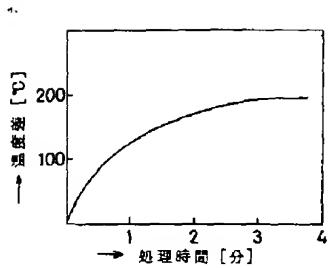
[Drawing 2]



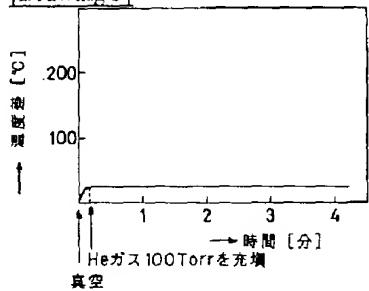
[Drawing 3]



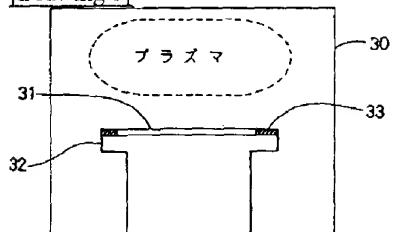
[Drawing 4]



[Drawing 5]



[Drawing 6]



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